ISOTOPIC AND GEOTHERMOMETRIC CONSTRAINTS ON THE STRUCTURAL AND METAMORPHIC EVOLUTION OF HOMESTAKE GOLD DEPOSIT, BLACK HILLS, SOUTH DAKOTA (USA)

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The Homestake Deposit, located in the northern Black Hills and host for 40 million ounces of gold, shows evidence for extensive remobilization of gold related to regional metamorphism deformation associated with the Early Proterozoic assembly of supercontinent Laurentia. Field and petrographic evidence for gold remobilization includes the occurrence of abundant quartz veins associated with selvages of chlorite-siderite-ankerite-pyrrhotite-arsenopyrite-gold in the Homestake Fm. The deposit is located on the western limb of a major anticlinorium that coincides with a vertical N-S-striking garnet isograd, and garnet-biotite geothermometry of metapelites sampled across the anticlinorium indicates a steep metamorphic field gradient of 150°C/km (east side warmer). This gradient is mirrored by a pronounced fractionation of oxygen isotopes observed in the vein quartz, with $\delta^{18}O$ ranging from 10 to 18 ppm. The isograd is parallel with a major N-S-striking shear zone, and kinematic indicators predominantly indicate oblique sinistral motion with east-side up. Garnet was separated from a subsurface sample of the Homestake Fm. collected from the nose of the so-called "main ledge" synform and subjected to Pb stepwise leaching (PbSL) to determine the age of garnet growth and thus metamorphism. PbSL analysis revealed a $^{207}\text{Pb}/^{206}\text{Pb}$ age of $1746 \pm 10$ Ma ($\pm 2\sigma$). Recent work in the southern Black Hills indicates that almandine does not contain sufficient Pb to be dated directly by this method; instead, the PbSL result represents the bulk age of abundant allanite inclusions observed in the
Thus, 1746 Ma is interpreted as a maximum age of prograde garnet growth during regional thermotectonism. Mineral assemblages from selvages in Main Ledge indicate that mineralization occurred at or after peak metamorph, which indicates that 1746 Ma also represents a maximum age for gold remobilization. A minimum 1715 Ma age of these events is indicated by published ages of post-tectonic leucogranite in the Black Hills. Regionally, the N-S orientation, 1746–1715 Ma timing, and sinistral-transpressive motion combine to suggest that this major shear zone in the northern Black Hills represents a northerly extension of the Hartville fault, which is exposed in SE Wyoming, ~200 km SSW. Correlation of these shear zones would have important implications for Proterozoic terrane assembly in this part of Laurentia.